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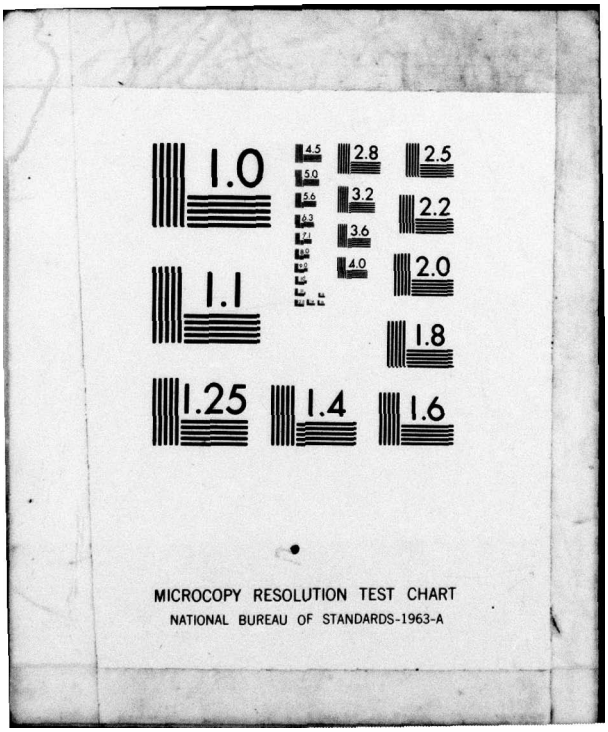
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DESERT CONVECTIVE CLOUDS

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February 1980

Final Report
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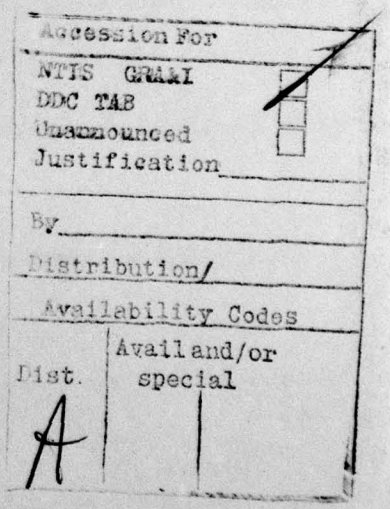

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20. Abstract

Equipment is being set up to measure various properties of desert clouds. The equipment includes a 3 cm. radar, a 0.86 cm vertically pointing radar, a GMD-1 rawinsonde, 12 weighing bucket rain gauges, cameras for stereophotography of clouds. The measurements will include cloud base, cloud height, growth rate of clouds, cloud base radius, rainfall rates, liquid water content, ambient atmosphere temperature, humidity, wind.

Along with the observational set-up, a one-dimensional time-dependent plume model has been developed for predicting growth of desert clouds. The program is almost completely checked out.

Information from the above-mentioned observational program will be used as input data and as verification data for the model.

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INTRODUCTION

The objectives of the research were to carry out detailed observational studies of the distribution, growth and decay of Negev cloudiness; of Negev rainfall and of the properties of the surrounding atmosphere, in an effort to improve our understanding of desert meteorology. At the same time we were to develop a dynamical model to simulate the behavior of Negev clouds. The methodology for the observational part of the program was to include, in the initial stages, detailed measurements of the growth characteristics of individual clouds by photogrammetric means, measurement of rainfall by a mesonet of rain gauges, and the measurement of the properties of the surrounding atmosphere by means of radiosondes. The methodology for the theoretical part of the program was to include the development, by physical and mathematical means, of a dynamical model to simulate the behavior of individual clouds, the assessment of the validity of the model by solving the pertinent equations by computer, and the comparison of the results with data from the observational part of the program.

Measurement Program

The measurements needed for developing and testing the simplest cumulus models are

A. Complete thermodynamic sounding,
   1. near in space
   2. near in time
B. Cloud base height, updraft radius and updraft velocity.
C. Cloud top height and tower radius as a function of time.
D. Radar echo RHI profiles as a function of time.

A radiosonde receiver was built for us, and was only very recently completed. We are now, finally, in a position to obrain thermodynamic soundings. In the meantime, we are obtaining a loan of a GMD-1 rawinsonde system, which is enroute to us. With this equipment, we will also be able to obtain upper level winds even in cloudy weather. The rawinsonde equipment will also enable us to obtain an idea of cloud base height and cloud top height. These parameters (cloud base and cloud top heights) can also be obtained by stereophotogrammetric means. We obtained a pair of stereo cameras for this purpose. Due to mechanical difficulties and personnel problems, we never succeeded in obtaining this information, as well as tower radius and updraft velocity. However, our situation has improved to the point where it is now possible to make such measurements.

We are in the process of, and have been doing so for 3 years, constructing an X-band radar. We had to suspend the construction of this radar (to be assembled from used parts) due to lack of funds. We recently received funds to continue this work, and are now going ahead to develop the radar with microprocessors and display systems, which will enable us to analyze Negev clouds and rainfall quantitatively.

In order to calibrate this radar, we will deploy the 12 weighing bucket rain gauges received under the grant. We had to modify the gauges (5 of which were in operating condition) so that they could be left unattended for 1 week rather than 1 day. In addition, we designed a different chart to accommodate the narrower rainfall range usually encountered in a Negev storm, as compared with that at mid-latitudes. The modifications produced very satisfactory results, when compared with the standard gauge. We are now ready to deploy these as part of an already existing Negev net. We will have to place one alongside an existing gauge for comparison of measurements (the existing gauges are Lambrecht, ours are Belfort).

We have recently received the AN/TPQ-11 vertically pointing radar. This equipment arrived without the receiving antenna. We are tracing the missing part. However, we think we can modify the set to work without this part, if necessary. We will be able to obtain information on inversion height, index of refraction, cloud base height (only if a cloud passes directly overhead). It will, however, be possible to modify this equipment to obtain other types of measurements in the boundary layer.

Theoretical Program

We have devised a one (space) dimensional plume model of a cloud, in which cloud growth is time-dependent. The equations we use are for:

1. Entrainment
2. Cloud temperature
3. Liquid water
4. Hydrometeor water
5. Vertical velocity
6. Fall velocity of drops
7. Radius of plume

The microphysics are paramaterized. The freezing process is included, as well as the evaporation process.

This program is being checked out, and is almost debugged. However, most of the input data needed, such as temperature, humidity, vertical velocity, cloud radius at cloud base, and temperature and humidity of the ambient atmosphere, are unavailable to us because of instrumental problems described in the previous section.

Concluding Remarks and Suggestions for Future Research

We plan to continue the work of the grant. It is only during the next few months that all of the efforts made to set up the instrumentation will finally begin to pay off. We will then be able to obtain the information we had hoped to get during the period of the grant. We will use this in the numerical cloud model.


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